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The Asia Science Letter is a bi-monthly publication of the Asian Office of Aerospace Research and Development (AOARD), Detachment 2 of the US Air Force Office of Scientific Research (AFOSR), the basic research manager of the Air Force Research Laboratory (AFRL). Its purpose is to inform the Air Force S&T community on the research and development activities in Asia and Pacific Rim countries including India and Australia. The assessments in this periodical are solely those of the authors and do not necessarily reflect official US Government, US Air Force, or AFOSR positions.

Highlights

I am delighted to announce the 1 July arrival of LTC (select) Mark L. Nowack and his family of six. Mark was Director of the Applied Mechanics Laboratory and an Assistant Professor at the US Air Force Academy in Colorado Springs. Mark received his Ph.D. from Cambridge University, UK, in Engineering Design, and M.S. from AFIT in Aeronautical Engineering. He has a broad range of technical experiences including materials, manufacturing, controls, spacecraft, landing gear, and robotics. He will be working closely with the AFOSR Aerospace and Materials Sciences Directorate and AFRL's Air Vehicles, Materials, and Munitions Directorates.

With much sadness, AOARD and the co-located Tri-Service offices bid farewell to Maj. Michele Gaudreault, her husband Pierre, and their four children. In late July, Michele headed for Wright-Patterson AFB to teach at AFIT. Michele has developed numerous personal connections both in AFRL and in Asia, and her contributions in establishing a first-class liaison organization in Asia were immense.

Of special interest in this issue:

- Dr. Sierakowski, Chief Scientist of AFRL/MN, delivered a keynote address at the 9th US-Japan Conference on Composite Materials (page 9)
- AOARD helped Dr. Dan Miracle from AFRL/ML and Dr. Brian Tsou from AFRL/HE with their technology assessment tour. (Features- page 2 & 3).

Koto White
Director

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Features

AFRL/MLLM Researcher visits Japan

Dr. Dan Miracle (AFRL/MLLM) traveled to Japan in June to present an invited talk *"Discontinuously-Reinforced Metals: Current Status and Opportunities"* at the Tenth Iketani Conference for Advanced Materials and Processes and to interact with Asian and European scientists on related topics of interest to the Air Force. Dr. Miracle also visited the following:

- **Kyoto University**

Dr. Miracle met with Prof. M. Yamaguchi in the Materials Science and Engineering Department. Prof. Yamaguchi heads a group of about a dozen researchers, including an Assistant Professor, graduate students and post-graduate students. About half of the work in his group is focused on hydrogen-absorbing materials for hydrogen storage, about 30% of the research remains in the area of TiAl for structural applications, and about 20% is devoted to silicide thin films.

- **National Research Institute for Metals (NRIM)**

Dr. Miracle traveled to NRIM at Tsukuba Science City with Tom Kim of AOARD. The host was Dr. H. Suzuki, the head of the Materials Processing Division. The major research themes at NRIM include metals for

(i) social needs such as environment, infrastructure and medicine,
(ii) research in high magnetic fields,
(iii) evolutionary development of existing metals and
(iv) exploratory research of new metals.

The total staff is 413, with 327 scientific/professional. The total budget amounts to $120M. Half of this is spent on research, with the largest blocks of funding dedicated to structural materials with twice the strength and life of existing infrastructure materials (20% of the R&D total), research on new superconducting materials (30% of the R&D total) computer materials research (12% of the R&D total) and general materials research (16% of the R&D total). The following technical areas were discussed.

- ***High Strength/High Conductivity Materials (Dr. H. Suzuki)***

The objective of this research is to produce high-strength materials with ≥80% the IACS electrical conductivity of Cu. Applications include high-field electromagnets and power lines for the Japanese network of high-speed trains (Shinkansen). The approach is to explore and develop materials based on the Cu-Cr system. Extrusion and wire-drawing refines and aligns the microstructure providing high levels of strength. This research is application-oriented with clear goals and a credible approach. Dr. Suzuki was a member of Committee on Technical Assessment of the Space Activities Commission. (See Space – page 13 "Investigation of the cause of launch failure of the H-II Launch Vehicle No. 8 and future measures.")

- ***Aperiodic Materials (Dr. A.-P. Tsai)***

The goal of this research is to identify new alloy systems that form stable quasicrystals, and to explore the novel properties provided by these materials. Empirical rules (Hume-Rothery) are used to search for new systems. Of primary importance is the electron-to-atom ratio, *e/a*. Two classes of alloys have been identified; Al-based alloys with transition metal (TM) additives and an *e/a* of ~1.7, and Mg-Al-Zn alloys with no TM and an *e/a* of ~2.1. The atomic size ratio of the alloy constituents (the 'confusion principle') is deemed to be of secondary importance. Ten alloys have been discovered to date. In general, these alloys have very high hardness and very low coefficient of friction, and so they are being considered as wear-resistant coatings. They are also being considered as catalysts in the chemical industry. Basic physical properties such as phonon vibrations and electrical resistivity are also being measured. Particularly intriguing is the discovery of thermodynamically stable quasicrystals, including Al-Fe-Cu alloys that can be cast into single crystals with a dimension of ~ 1 cm.

- ***High Temperature Metals (Dr. T. Hirano)***

Dr Hirano's presentation focused on the production of Ni_3Al foil. Single crystal plates are cast, then cold-rolled to foils ~50 μm thick. No intermediate anneals are used during the cold-rolling process. Properties of the foil have been measured. No applications have been identified. Trials to produce honeycomb have been attempted.

- ***Metallic Composites (Dr. C. Masuda)***

The goal of research in the Metallic Composites group is to develop materials with high specific properties. Most of the research in Dr. Masuda's activity currently focuses on Ti-alloy and Ti-aluminide materials reinforced with continuous SiC monofilaments. Efforts include experiments and modeling of thermomechanical response. Additional efforts discussed by Dr. Masuda included the incorporation of shape memory alloys, single crystal optical fibers, piezo foils for self-sensing, and self-repairing materials. Limited work on discontinuously-reinforced Al and Al-Li has been performed.

- **Institute of Materials Research, Tohoku University (IMR)**

Dr. Miracle traveled to IMR and Tohoku University in Sendai. The IMR was organized in 1987 as a national

collaborative research institute, and is attached to Tohoku University. The IMR is a national center of excellence in Japan for the basic and applied research of metals. The IMR has a rich history of technical innovation and applied science, with the most notable achievements made in steels and magnetic materials. The research laboratories are arranged in four divisions (i) Materials Properties, (ii) Materials Design, (iii) Materials Development, and (iv) Materials Processing and Characterization. There are thirty research groups in these four divisions. Each research group is headed by a professor and is further staffed by an associate professor, a research assistant and graduate students. The permanent scientific staff numbers ~150 (19 professors, 34 associate professors and 95 research associates). There are 150 graduate students (102 MS, 53 Ph.D.) and 45 visiting scientists. The total support staff is ~175. The professional staff and students represent 11 foreign countries, with the largest numbers from China and Korea. The budget has remained relatively constant since 1995 at ~$55M.

➢ ***Non-Equilibrium Materials (Prof. A. Inoue)***

Dr. Y. Kawamura who is a member of research staff of Prof. Inoue hosted Dr. Miracle. The Research Activity on Non-Equilibrium Materials is a large group (22 scientists) with a long history (Prof. Masumoto produced the first metallic glass at the institute in 1969). Since that time, the group has produced ~1500 publications. The group has an impressive array of equipment, including several melt-spinners, two extrusion units, a gas atomization unit with in-line controlled-atmosphere powder handling, laser ablation, a nanoindenter and several DTA and DSC units. The principle objective of this research seems to be the exploration of new metallic glass systems and the characterization of unique behavior, especially mechanical and magnetic properties. An effort to predict and explore the full compositional range of glass-forming alloys was evident through the published papers and displays. Applications for magnetic metallic glasses include electromagnetic actuators, various read/write and recording mechanisms for magnetic media, transformers and protection of magnetic media from electromagnetic fields. They displayed an amorphous sheet up to ~12 cm wide. The only current structural applications were golf clubs (both P/M and cast) and underwire bras. A biological application, stitching for insoles (kills bacteria), has also been placed in production.

Additional specific details are available for NRIM and IMR. For additional information, contact Daniel Miracle at (Daniel.Miracle@wpafb.af.mil). (Miracle & Kim)

AFRL/HE Scientist visits Singapore, Japan & Taiwan

From 5 to 22 June 2000, Dr. Brian Tsou (AFRL/HE) conducted technical discussions and visited laboratories in Singapore, Japan, and Taiwan.

In Singapore, Dr. Tsou is undertaking collaborative research on the myopic requirements for aerospace night vision displays under a Project Agreement with the Singapore Defence Medical Research Institute (DMRI). Dr. Tsou and DMRI tentatively agreed on the experimental design of the project and are continuing discussions to finish the clinical protocol for the subject's ocular refractive evaluation. DMRI is also ready to discuss another Project Agreement on CFD modeling of life equipment design for safety. Furthermore, DMRI will make their comprehensive anthropometric database (100 anthropometric dimensions of more than 2000 males) available to AFRL researchers who have a need. Please contact Dr. Tsou directly (DSN 785-8896 or brian.tsou@wpafb.af.mil) for DMRI request forms. Dr. Tsou also met with the Singapore Republic Air Force's Chief of Medical Officers, Colonel Tan, who is also Director of Singapore's Aero Medical Centre. Col Tan is also interested in collaborative acceleration research with HE.

In Japan Dr. Tsou visited AOARD, Shimadzu, Hamamatsu Photonics, and Hitachi Medical Corp. to evaluate new brain imaging technology, infrared CT.

- **Shimadzu Corp., Fundamental Technology Research Lab., Hadano-city, Kanagawa-prefecture ; 7 June 2000 (POC: Dr. Tsunazawa).** Dr. Tsou visited Shimadzu to evaluate their equipment and optical CT's capability. Shimadzu was founded on the manufacture of scientific equipment in 1875 and today is one of the world's leading manufacturers of imaging systems for medical applications. Core technologies for the Hadano Works include x-ray systems, optical systems, and image processing. Research at the Fundamental Technology Research Lab includes the study of laser, x-ray and optical CT. Shimadzu was a partner in the joint NEDO-MITI project lead by Professor Tamura of Hokkaido University. Optical CT has very good temporal resolution but is less than MRI in the spatial domain. Shimadzu is continuing R&D efforts to improve the imaging capabilities and resolution of IR CT.

- **Hamamatsu Photonics, Central Research Laboratory, Hamakita-city, Shizuoka-pref.; 8 June 2000 (POCs: Dr. Tsuchiya and T. Yamashita).** The Hamamatsu Photonics Central Research Laboratory conducts basic and applied research in photonics technology. Hamamatsu was also a partner in the joint NEDO-MITI project led by Professor Tamura. There are two approaches to optical measurement: continuous-wave and time-resolved. Hamamatsu is using pulsed IR and time resolved techniques in-vivo and tissue-like phantoms to achieve the absolute quantification of oxygen in the tissues using IR spectroscopy. Studies are ongoing to determine the time of flight of the IR photon in the skull and cerebral cortex. Hamamatsu is also trying to address limitations in IR CT caused by light scattering properties of tissues; research is being conducted to analyze photon migration in tissue.

- **Hitachi Medico, Development Div. of Applied Equipment, Kashiwa-city, Chiba-pref.; 9 June 2000 (POCs: Dr. Ichikawa and M. Fujiwara).** Hitachi Medical Corporation manufactures and sells X-ray and computerized tomography systems, medical electronic equipment, therapy systems, industrial x-ray systems, and other related medical instruments. Hitachi is nearing the completion of a commercial IR CT product for medical diagnostics. Fifteen units have already been sold to customers in Japan. Dr. Tsou visited Hitachi to evaluate their infrared CT device.

In Taiwan, Dr. Tsou visited the National Science Council (Department of International Programs), National Taiwan University, the Industrial Technology Research Institute (ITRI), and the Aviation Physiology Research Laboratory.

- **Department of Computer Science and Information Engineering, National Taiwan University, Taipei, Taiwan; 16 June 2000 (Professor Ming Ouhyoung)**. Professor Ouhyoung is active in introducing affordable user interfaces such as head trackers, stereo displays, etc. and in studying the effect of these devices on the user. For example, using technologies of compressed voice, parameters of expression, and a 3D-head model, he has developed a "talking head" using only 8 KB/s bandwidth. Professor Ouhyoung is the Organizer of the 10th International Conference on Artificial Reality and Tele-existence (ICAT2000) in Taipei, 25-27 Oct, on virtual reality science and technology. He discussed the possibility of inviting an AFRL/HE Invited Speaker to this conference.

- **Industrial Technology Research Institute (ITRI), Hsinchu, Taiwan; 16 June 2000 (Hansen T. Lee, ITRI Office of Planning and Yung S, Liu, OES Deputy General Director).** ITRI is a private, non-profit R&D center, 50% funded by industry. Of the staff of 6,000 over half have advanced degrees. At the Computer and Communications Research Laboratories we visited the IC Design & VR Technology Division (Dr. Li-Sheng Shen, Director) and toured their CAVE facility, which is an immersive "aquarium", multi-viewer (10 users), and low-cost projection system. It is developing a virtual 3D-viewing tour to simulate submerged experience/environment for entertainment. We discussed human factors issues related to using 3D systems, in general, and CAVE, in particular.

  At the Opto-Electronics & Systems Laboratories we visited the 3D Advanced Technology Program (Wen-Jean Hsueh, Program Director). We discussed human stereo vision, 3D display requirements, and user fatigue related to problems in image fusion and mismatches between accommodation and vergence. OES is also active in 3D scanning and modeling. Two whole body scanners have been developed at OES: one at the Textile and Garment Research Center and the other at Chung Gung Hospital in Taipei, being used to study the pedictiveness of 3D anthropometry data in health surveillance. In addition, we also visited the Color Technology Section (Chun-Yen Chen, Section Manager). (Lyons)

Electronics and Physics

Workshop: Research Progress of Photonic Crystals in Japan, Tokyo, 19 July 2000. Photonic crystals are microstructured materials in which the dielectric constant is periodically modulated on a length scale comparable to the desired wavelength of operation. Intricate lattice-like structures can trap and channel light - the optical equivalent of semiconductors. Theoretically, a new concept of "**photonic band**" was proposed in 1979 by Prof. Ohtaka (Tokyo Univ.), and "**photonic band gap**" was also shown in 1987 by Dr. Yablonovitch (Bellcore). Since then, considerable progress has been achieved in fabricating two-dimensional structures. In the last two years, many theoretical and experimental research efforts started in Japan. On 8 March 2000, the International Conference on Photonic and Electromagnetic Crystal Structure (PECS) was held in Sendai.
This workshop included an Introductory Talk on Photonic Crystal World by Baba (Yokohama National Univ.),

Characteristics of Photonic Bands and Their Calculation by Ohtaka (Chiba Univ.), the Consequence of the Group Velocity Anomaly due to the Band Structure of Light by Sakoda (Hokkaido Univ.), Semiconductor Photonic Crystals by Noda (Kyoto Univ.), Fabrication of Photonic Crystals by Using Autocloning Technique by Kawakami (Tohoku Univ.), Physics of Light Propagation in Photonic Crystals and Its Applications by Notomi (NTT), Photonic Crystal Technology Roadmap by Optoelectronic Industry and Technology Development Association (OITDA).

Laser oscillation using two-dimensional semiconductor photonic crystals was achieved recently and progress in three-dimensional structure technology is leading to spontaneous emission of the photonic crystal equivalent to a single impurity laser. These were largely dependent on contributions from nanotechnology and MEMS. Recent notable achievements were prominent experimental results of photonic super prism (NEC), 120 degree steeply curved waveguide (NEC) and fabrication of three-dimensional GaN photonic crystals for visible spectrum (Kyoto Univ.). The roadmap suggested an expansion of photonic crystals application into information technology, communication and wide range of consumer industries within a few years. (Miyazaki)

Site Visit: Academia Sinica, Nankang Taiwan, National Tsing Hua and Chiao-Tung Universities, Hsinchu Science-Based Industrial Park, Hsinchu, Taiwan, 31 March – 1 April 2000. Academia Sinica is Taiwan's premier academic institution. Founded in Shanghai in 1928 before re-locating to Taiwan, it answers directly to the Presidential Office and operates with an annual budget of about $150 million. The Institute conducts in-depth research that spans the sciences and humanities. Its research staff numbers over 800. The organization is made up of academicians, whose title as such is a lifetime privilege. Of the almost 200 academicians, however, only about 50 reside in Taiwan. This situation is changing due to efforts of Dr. Y.T. Lee, its current president and 1986 Chemistry Nobel Laureate, who is successfully inviting outstanding scholars to return to Taiwan.

Among the Academia's Institutes in the mathematical and physical sciences are Physics, Chemistry, Earth Science Information Science, Atomic & Molecular Sciences, Astronomy and Astrophysics, and a new Center for Applied Science & Engineering Research (CASER). Their focus and accomplishments include:

- Physics: long-term projects on nanoparticles, nonlinear & computational physics.
- Chemistry: inorganic, organometallic, physical and biochemistry.
- Earth Sciences: seismology, tectonophysics, geochemistry, physiochemical investigation methods, the study of magma-generation along the Japan-Taiwan-Philippine volcanic chain and deployment of 100's of arrays and stations to monitor and analyze the tectonic stress system affecting the region; developed pressure cells which have achieved the world's highest pressures (16.7 GPa cubic zirconia cell and 25.8 GPa sapphire cell).
- Information Science: software-focused programs in intelligent systems, language & image recognition, processing and analysis, and parallel processing.
- Atomic & Molecular Sciences: physical principles relevant to material science, energy research, and laser technology; molecular reaction and dynamics, photochemistry and molecular spectroscopy; condensed matter and surface science. Besides studying DNA-dye complexes and growing GaN thin films, this Institute constructs apparatus for the study of reactions and has developed femtosecond analysis techniques (e.g., for biological electron transfer study) and a photochemical process to assist in near-field scanning optical microscopy.
- Astronomy and Astrophysics: radio astronomy, particularly millimeter and sub-millimeter interferometry. In collaboration with the Universities of California-Berkeley, Illinois, and Maryland their work uses an established millimeter interferometric array. In agreement with the Smithsonian Institute, this Institute is building and expanding the world's first sub-mm interferometric array. The additional 2 sub-mm-wavelength telescopes to be built in Taiwan will augment the Smithsonian Astrophysical Observatory array, thereby doubling the speed of the now-8-element array. The Institute also has programs in IR instrumentation, primarily to research the intensity and polarization anisotropies of the cosmic background radiation.
- Institute for Applied Science and Engineering Research (CASER): interdisciplinary, system integration, product potential, micro-electromechanical systems (MEMS), high-density storage and display technologies, advanced electronics, optoelectronics and materials, internet-related technologies. This ambitious new Center is directed by Dr. C.S. Tsai (also of the University of CA at Irvine), in alliance with the other Institutes and was founded to pursue frontier research collaborations in Taiwan and abroad.

Further information can be found at the website http://www.sinica.edu.tw (Maurice)

Site Visit: Meteorological Research Institute (METRI), Seoul, Korea, 29 February 2000. METRI is South Korea's independent national meteorological research organization. Its objective is to advance atmospheric science with an emphasis on East Asia and in support of Korea's Meteorological Administration (KMA). METRI's R&D role in atmospheric science includes climate prediction, change and modeling, and marine and observational meteorology.

- Activities of the Forecast Research Lab at METRI are in short-to-long-term forecasting and include dynamic and numerical studies of the mechanisms and structure of monsoons.
- The Marine Metrology Lab's focus is on the prevention of marine disasters, especially storm surges, tsunamis and hazards spawned by seismic activity.
- Activities in the Remote Sensing Research Lab are related to the upper atmosphere and involve satellite meteorology via remote sensing data and equipment. Atmospheric data is abstracted from satellite data. Monitoring and diagnostic techniques are developed, including retrieval algorithms and image display techniques.
- The Applied Meteorology Research Lab is devoted to understanding the atmospheric environment. It monitors greenhouse gases and studies industrial, aeronautical, agro-, micro- and bio-meteorology. Its tools are the application and analysis of remote sensing, mainly by satellite and radar. The Lab also studies aerosol phenomena such as the Yellow Sand, a problematic yearly phenomenon by which a dust plume originating in China's deserts is kicked high into the upper atmosphere and transported over long distances, affecting the global ecosystem and the absorption and scattering of light.
- Hydrometrology Research Lab's focus is on weather modification and cloud physics (the dynamics of which involves heat transfer, fluid flow, and even fractal dimension geometry), radar meteorology, and land-surface atmosphere interaction (evapo-transpiration and the water cycle).
- METRI's "Background Air Pollution Monitoring Network (BAPMoN)" Observatory is one in a node of such observatories worldwide to monitor air pollution.

METRI has recently been awarded an R&D contract with AOARD to investigate the Yellow Sand via Lidar-derived multi-spectral irradiance data. (Maurice)

Site Visit: Department of Electrical and Electronic Engineering, Yamaguchi University, Japan, 23 February 2000. The research interests of the EE Department of Yamaguchi Prefecture's major university span all of electronics; quantum semiconductors, circuit integration, communications, superconductivity engineering, power electronics, and energy conversion. Two focuses of the Department are optoelectronic materials and radio-frequency (RF) devices.

Central to the Department's materials work is Dr. T. Taguchi, formerly of Osaka U. He has considerable expertise in both II-VI and III-V compound semiconductor groups and is well-known to the semiconductor community. Dr. Taguchi heads up the Ministry of International Technology and Industry's NEDO Nitrides project, "New light source for the 21st century". The goal of this "New Sunshine" project is nitride-based Light Emitting Diodes (LED) having high external quantum efficiency - an expansion of the 1995 achievements of Dr. Shuji Nakamura (then at Nichia Chemical). Groups under Drs. Taguchi and Y. Yamada are actively reporting on excitonic optical properties of wide-bandgap II-VI and III-VI group quantum-well structures (ZnS, ZnSe, and GaN-based) grown by molecular beam epitaxy (MBE) and metal-organic chemical vapor deposition (MOCVD). One of their Nitrides students (Mr. Kubo) won the Best Student Paper Award at the Photonics 2000 SPIE conference in Taiwan (July '00).

Work at the Light and Electromagnetic Wave Devices Engineering Lab is focused on devices rather than materials. Researchers under Drs. I. Awai and M. Hotta (formerly of Ehime U.) in conjunction with Dr. T. Itoh of UCLA are developing novel resonant coupling-type microstrip line interconnects using alternative geometries. This work has key applications in microwave integrated circuits (MICs) and monolithic microwave integrated circuits (MMICs). With extensive experience in special-function waveguides and transmission lines, they are developing key low-loss circuit elements towards these ends. Particularly, conductor-backed co-planar waveguides using ribbon bonding and a dielectric pad. (Maurice)

Human Systems

Site Visit: Ministry of State for Research and Technology, Jakarta, Indonesia (Professor Dr. Ir. Sulaeman Kamil, Assistant to the Minister of State for Research and Technology), 15 - 16 May 2000. Robin McClellan, First Secretary for Science, Technology, and the Environment of the U.S. Embassy, and Dr. Lyons from AOARD met with Professor Dr. Ir. Sulaeman Kamil, Assistant to the Minister of State for Research and Technology. The next day Dr. Kamil arranged a meeting with Dr. ir. Ichsan S. Putra, the Head of the Department of Aeronautics and Astronautics of the Institute of Technology at Bandung (ITB) and other members of his Department. ITB is the oldest Technological University in Indonesia, founded in 1920. The Department of Aeronautics and Astronautics is in the Faculty of Industrial Technology. This Department, with approximately 40 staff members, educates approximately 70 aeronautical engineers per year in addition to Masters and Ph.D. Students. Areas of research interest include aerodynamics, structures/materials, flight mechanics, aircraft design, and aeroelasticity. (Lyons)

Site Visit: Lakespara Saryanto (Aeromedical Institute), Jakarta, Indonesia (Dr. Hidayat, Commander), 15 May 2000. This Institute conducts screening of Indonesian aircrew and physiologic training as well as research and operational support activities. Twenty flight surgeons on staff perform aeromedical exams as well as providing other medical care. Facilities include a hypobaric chamber and mono-place hyperbaric chamber. A new Latecore centrifuge is currently being installed. Research activities are also being conducted in collaboration with the University of Indonesia. (Lyons)

Site Visit: Institute of Design and Ergonomics Application (IDEA), Universiti Malaysia Sarawak (UNIMAS), Sarawak, Malaysia; 31 March 2000 (Professor Halimahtun Mohd Khalid, Director). One of 12 Malaysian government Universities, UNIMAS, on the exotic island of Borneo, is relatively new - accepting its first students in 1993. Established in late 1996, the Institute of Design and Ergonomics Application (IDEA) combines design, ergonomics, and technology. It is the only research Institute in Malaysia specializing in ergonomics research and development.

Research activities encompass design and ergonomics studies in niche areas such as e-design interfaces, web-based design for mass customization, anthropometry measurement technology, virtual collaboration in product design using the virtual environment as support for decision making, application of Kansei Engineering in product design, multi-media usability, and dialogue design of speech interfaces for bi-lingual communication (Malay-English).

In addition to conducting post-graduate education, IDEA conducts professional training short courses including a March 2000 workshop on Anthropometry sponsored by AOARD (see ASL vol. #26). IDEA is also active in university-industry collaboration with Sirim Berhad (the standards institution for Malaysia), NIOSH Malaysia, Malaysia Design Council, Shell Malaysia, Proton Berhad (Malaysia automaker), Mimos Berhad, and Multimedia Development Corporation that drives the Multimedia Super Corridor initiative. (Lyons)

Site Visit: Department of Environmental Conservation, Ehime University, Matsuyama, Japan; 7 March 2000. The Department has approximately 20 graduate students, including some from southeast Asian countries. Professor Tanabe has been active in research projects in Southeast Asia and in the Canadian Arctic. His study of bioaccumulation of dioxin, PCBs, and DDT in seals in the Canadian Arctic was recently televised as a special program on Japanese T.V. Research areas at Ehime include the following:

- Field analysis of environmental movement including tidal current and density current, analysis of the development of oxygen poor water mass, red water, and toxin movement in the environment.
- Study of changes in marine pollution, accumulation of toxins in the marine ecosystem, and bioaccumulation mechanisms in fish, birds, and marine higher mammals (such as seals), and humans. Toxicity studies include organic chlorine compound (PCB and Dioxin), agricultural chemicals (DDT and BHC), organic tin compound (TBT), and heavy metals (Cd, Hg, and Pb).
- Research analysis of ecosystem dynamics based on short/long term monitoring of the biological community in the coastal areas. The following are being analyzed: biomass, species represented and their distribution, plankton, red tide, algae, analysis of biological indicators, microbiological food chain, biological diversity, and river ecology.
- Study of the submarine sedimentary layer including the prediction of coastal environment changes.

Attached to the University is the Nakajima Marine Station marine biological laboratory located on the western edge of the Inland Sea (Setonaikai). The station has a small research vessel (11 tons), investigating/collecting tools,

and basic facilities for biological observation. Outside visiting researchers also use these facilities. (Lyons)

Material Science

Final Report (Contract #: F6256299M9126): "Stresses in bonded repair to cylindrically curved shell structures," Liyong Tong and Xiannian Sun, Department of Aeronautical Engineering, University of Sydney. Adhesive bonding has been used to join or repair metallic and composite structural components to achieve or restore their designated structural stiffness and strengths. However, current analysis methods and empirical databases for composite bonded joint design and for composite bonded patch repair are limited to flat plate and/or flat laminate geometry, and the effect of curvature on the performance and durability of composite bonded joints and repairs is not known. This report presents a novel finite element formulation for developing adhesive elements for conducting 2.5-D quick stress analysis of bonded repairs to curved structures. Both large deflections of the parent structures and nonlinear adhesive behavior are incorporated in the formulation. In-house software called BPATCH has been developed. A variety of examples are presented to illustrate the effect of curvature, large deflection and adhesive nonlinear behavior on stresses in adhesive layer. The results from the selected numerical examples demonstrate the following points.

- The curvature of a parent structure may have a profound effect on peak stresses in adhesive layer, depending on loading and boundary conditions.
- The peak peel and shear stresses may increase or decrease with an increased curvature depending on loading and boundary conditions.
- Externally bonded patches seem to create less peak peel stress than internally bonded patches for the cylindrical shells under an internal pressure, while internally bonded patches seem to create less peak peel stress than externally bonded patches for the cylindrical shells under an external pressure. In other words, external patches are preferred when the shell is under an internal pressure while internal patches are preferred when under an external pressure.
- Both large deflection and adhesive nonlinear behavior can have a significant influence on the peak values and distributions of the three stresses in the adhesive layer.
- External patching is preferred when a cylindrical shell is subjected to a negative temperature change.
- The size and thickness of the bonded patch may have an important effect on the peak peel stresses.

Thermal loading is also incorporated in the formulation to enable analysis of bonded repair under a combined mechanical and thermal loading. The newly developed elements can be used to quickly calculate stresses in the adhesive layer of bonded repairs to curved thin-walled structures. The adhesive element provides an efficient and cost-effective means of modeling bonded overlap area in bonded repairs. For a copy of the final report, please contact AOARD or Prof. Tong (ltong@aero.usyd.edu.au). (Kim)

Research Contract: "Fabrication of PMN-PT Single Crystals by Using the Exaggerated Grain Growth Method," Prof. Doh-Yeon Kim, Center for Microstructure Science of Materials, Seoul National University, Korea.
This research has direct applications to Air Force's interest in improving materials for aircraft and spacecraft control systems. For example, a single crystal form of piezoelectric materials for smart actuators used in control systems will enable the control to be closed loop more precisely.

This research will provide an increased understanding of exaggerated grain growth (EGG) or abnormal grain growth (AGG) in certain types of polycrystalline materials where a few grains grow extensively at the expense of fine matrix grains during the heat treatment. This phenomenon usually is detrimental to the mechanical strength of structural components. The rate of exaggerated grain growth (EGG) is orders of magnitude higher than that of the flux or melt growth. Therefore, when EGG is strictly controlled, the single crystal can be grown with a relatively high rate in the solid state (~200 micrometer per hour). For growing a single crystal by EGG, the number of "nuclei" for EGG should be maintained at a minimum. Prof. Kim proposes to control nucleation by imposing the chemical inhomogeneity (e.g., PbO additive) and/or by applying the temperature gradient to the PMN-PT polycrystalline specimen. He estimates that this fabrication method will cost at least 20 times less than the melt method. Both basic and developmental research will be carried out simultaneously to provide a breakthrough.

The overall objectives of this research are to analyze the EGG mechanism, and develop a simple and cost-effective fabrication method of PMT-PT single crystals. Prof. Kim's group has already demonstrated an occurrence of EGG in $BaTiO_3$ polycrystalline specimen and expects to grow a large-size crystal by properly controlling the nucleation process. This research contract is under the

Asian Initiative and was evaluated by Dr. Alexander Pechenik (AFOSR/NA). (Kim)

Conference: The International Union of Materials Research Societies - 6th International Conference in Asia, Hong Kong, 24-26 July 00. The conference consisted of six concurrent sessions:

- Advanced Electron Microscopy for Materials Science,
- Multi-scale Materials Modeling,
- Nano-scale Materials,
- Organic Electroluminescent Materials and Devices,
- Scanning Probe Microscopy for Materials Characterization, and
- GaN and Related Wide Band Gap Semiconductors.

The keynote speaker was Professor Sir Harold Kroto from University of Sussex, UK, who won the Nobel Prize for Chemistry in 1996 for his discovery in C60 Buckminsterfullerene. Highlights from the Advanced Electron Microscopy session that I attended included:

Prof. H. Ichinose (The University of Tokyo) showed high resolution images of diamond and silicon carbide from a newly constructed High Voltage Transmission Electron Microscope (HVTEM) at the University. He explained in detail the Engineering feat of constructing the 15 meter tall, 280 ton microscope with 1250 KV acceleration voltage that makes the sub-angstrom-resolution atomic imaging possible (actual resolution is currently at 1.2 angstrom). It is possible to study the atomic arrangement at an internal interface using this microscope. Questioned by an audience from China on the cost of the microscope, he answered "It's a national secret." There are seven such HVTEM existing in the world, and four of them are in Japanese universities.

Prof. Takayanagi (Tokyo Institute of Technology) reported his elegant experiment on electron transport mechanism through a gold nano-wire. He used Scanning Tunneling Microscopy, TEM, and electrical resistivity measurement simultaneously, and correlated the change in the resistivity, while pulling the wire, to the number of atomic strands remaining. He discovered that the conduction through the wire was quantized even at room temperature. This phenomena was not observed in a point contact where no atomic strands are involved. Thereby, he concluded that the quantization occurs only when the electron transport is under a ballistic condition, through a narrow conduction channel.

Dr. J. M. Gibson (Argonne National Laboratory) developed a new electron microscopy technique called "fluctuation microscopy" based on a statistical variation of micro-diffraction (collected through a restricted aperture) as a function of position. This technique is well suited to detect medium-range order while other diffraction techniques are for examining short-range order. He observed that the as-deposited amorphous films of silicon and germanium had a prominent medium-range order which disappeared after annealing, i.e., the films became more amorphous after annealing. He explained this counter-intuitive phenomena by the Gibbs Free-Energy model of grain-size effect.

Several other excellent experiments that correlated physical properties with a direct observation of atomic arrangement were reported at this conference. Overall, the advancement in microscopy in recent years seems to be due to the enhanced computer data analysis capability while the microscopic measurement concepts remain the same. (White)

Site Visit: Prof. Toshio Tanimoto, Composite Materials Laboratory (CML), Shonan Institute of Technology, Fujisawa, Japan, 24 July 00. The CML is a research unit of the Department of Materials Science and Ceramic Technology that is focused on composite materials analysis, design, processing, and application. Prof. Tanimoto has been involved in the evaluation of damage tolerant behavior of synthetic composites by utilizing patterns observed in biological materials. The mechanical properties of biomimetic laminate (stacking sequence such as found in those animal hard tissues, fish scales, and insect cuticles) were compared to a standard quasi-isotropic and a cross-ply laminate. The residual compressive strength properties of a biomimetic laminate after impact damage was evaluated. The results showed that the biomimetic laminate has a higher resistance to the impact damage. Prof. Tanimoto's other research areas include the introduction of polymer interleaves between the plies of composite laminates to increase the interlaminar stresses. This effects the propagation of cracks through the material and improves the impact resistance of laminated plates. Similarly, the introduction of interleaf layers with properties different from those of the composite plies improve the vibration properties (damping) without significantly affecting the static bending and in-plane properties of the laminate. This project sets out to determine a systematic approach for the production of laminates with improved vibration damping. (Kim)

Conference: The 9th US-Japan Conference on Composite Materials, Mishima, Japan; 3-4 July 2000. This conference has been held every two years alternately in the US and Japan since 1981. The 170 participants included 30 researchers from the US and 5 invited

speakers from other countries other than Japan. Prof. Hiroshi Fukuda (Science University of Tokyo) and Dr. Takashi Ishikawa (National Aerospace Laboratory) organized this year's conference and Dr. Robert Sierakowski of AFRL/MN delivered an opening keynote address. 111 papers were presented and covered all areas of composite materials research and development. In particular, the conference emphasized:

- low cost composite structures (Plenary lecture by Prof. K.T. Edwards and Prof. A.C. Loos)
- composites for infrastructure (Plenary lecture by Dr. Y. Rajapakse, Prof. V. Karbhari, and Prof. K. Maruyama)
- smart and intelligent composites (Plenary lecture by Prof. M.W. Hyer, Prof. N. Takeda, Prof. F-K. Chang, and Prof. C.S. Hong)

Dr. Koun Takahashi of Ishikawajima-Harima Heavy Industries presented a paper on the development of a composite flywheel rotor. This composite rotor was designed based on finite element analysis and fabricated to achieve a peripheral speed of 1300 m/s (6200 rpm). The rotor consisted of a composite rim and an aluminum alloy (7075) hub. The rim was a multi-ring structure fabricated by a filament winding process using Toray (T1000G) fiber and epoxy resin. The testing confirmed that the composite flywheel rotor stored energy of 354 Wh and the specific energy density of the ring was 195 Wh/kg at maximum peripheral speed of 1310 m/s.

Dr. Mitsuru Kobayashi of Mitsubishi Heavy Industries presented a paper on the development of an H-IIA launch vehicle composite interstage structure. The interstage typically is an outer shell structure that supports the first stage and second stage of a launch vehicle. The new interstage structure of the H-IIA launch vehicle was developed by co-curing the composite facesheet onto a form core sandwich structure. This manufacturing process reduced the cost by 30% and reduced the weight by 20% when compared to an aluminum structure. Most of the cost reduction was due to faster assembly time and reduced parts manufacturing. The 4-meter diameter by 7-meter length interstage weighed 820 kg and was qualified by the full-scale strength test. This interstage was designed to withstand axial compression of more than 4.38 MN. (Kim)

Conference: 2000 International Workshop on Superconductivity, Matsue-shi, Japan, 19-22 June 2000. This was the 12th of the workshops sponsored annually by International Superconductivity Technology Center (ISTEC), a nonprofit foundation supported by 75 corporations and approved by the Ministry of International Trade and Industry in 1988. The focus of the workshop was on the microstructure-property relationships for large-scale applications of high-temperature superconductors (HTS).

Grain boundaries dictate many properties of polycrystalline materials in general. Since we are likely to continue using polycrystalline HTS rather than single crystals for large-scale applications, understanding and controlling the characteristics of grain boundaries is important. Many researchers reported hindrance of superconducting current by grain boundaries, especially by the ones with high mis-orientation angles. As high-angle grain boundaries are common in large-scale materials, this will limit the large-scale high current-carrying applications. However, H. Hilgenkamp (University of Twente, The Netherlands) showed that this can be overcome by Calcium doping. The issue of controlling the stoichiometry and microstructure at the boundary is also important for the grain-boundary-based electronic devices (such as SQUID) for their predictability and reproducibility. Therefore, many researchers addressed this topic.

There were many presentations on improving the "texture" of HTS tapes. Crystal structure of HTS is highly anisotropic and they are often thought of as a layered structure where copper oxide planes are sandwiched by other metal oxide planes. It is experimentally proven that both the normal conduction and super conduction are much greater through the copper oxide planes. Therefore, various techniques have been developed to texture materials so that the copper oxide planes are aligned in the direction of the transport current to improve conduction.

A vortex consists of a tightly circulating electron current around a non-superconducting core parallel to the external magnetic field and magnetic flux threading through the core. It appears as a regularly spaced array in all Type-II superconductors including HTS. As the external field is increased and/or temperature is raised, a vortex frees itself from the pinning center (i.e., crystalline defects) and starts migrating under the Lorentz force exerted by the transport current. This de-pinning phenomena leads to the lowering of critical current density. Tonomura (Hitachi Ltd.) reported a real-time observation of vortex motion using Lorentz microscopy based on the phase of electron currents around the vortices. He suggested the vortex pinning mechanism (by oxygen vacancies and dislocations) as a function of temperature and external fields. There were active discussions on the effective means of pinning and on the controlled introduction of pinning centers (defects) in HTS to increase critical current density. (White)

Conference: 12th International Conference on Ternary and Multinary Compounds, National Tsing Hua University (NTSU), Hsinchu, Taiwan, 13-17 March 2000. The 12th ICTMC conference convened in Taiwan with coverage of current topics in multinary solid-solution compounds. Over 200 researchers participated, mostly academic representing major universities in Japan, Taiwan and Europe, especially Russia.

Because these compounds are structurally reducible to a few archetype crystalline structures and corresponding derivatives (mixed crystal systems such as NaCl types, pyrite, chalcopyrite types, and perovskite types), the conference emphasized compounds of certain mixed crystal systems, particularly those where material structure and properties can be changed from insulating and semiconducting to metallic and superconducting by the exchange of constituent atoms. Atomic placements and displacements, meta-stabilities and surface/substrate interfaces all induce material property changes. The importance of understanding growth mechanisms and reaction kinetics during the growth process was emphasized. Highlights include:

- I-III-VI_2 ternary semiconductor compounds displaying chalcopyrite structure: Techniques and growth mechanisms for chalcopyrite semiconductor thin films for use as absorbers in photovoltaic devices was a big focus. Due to their tolerance to radiation ("rad hardness"), films based on $CuInSe_2$ and $Cu(In, Ga)Se_2$ (CIS and CIGS) materials are the most promising candidates for space-based applications. Japan reported work on these compounds as films and single crystals for use as light emitting devices, with photoluminescence (PL) in the near-IR. Additionally, Japan reported 1) Cu-III-Se_2 chalcopyrite-type semiconductor heterostructures grown on GaAs by metal-organic molecular beam epitaxy (MOMBE) (Ehime U.), 2) high quality (low intrinsic defect) CIS films grown by Molecular beam epitaxy (MBE) on GaAs (MITI's Electrotechnical Lab), and 3) first-time growth of $Ag(Al_xGa_{1-x})S_2$ (Niigata U., epitaxial growth).
- Magneto-optic, conducting & superconducting materials:
  - Synthesis of diluted magnetic semiconductors, ferroelectric semiconductors and those for giant magnetoresistance (Ehime University, Japan, and National Taiwan University, Taiwan)
  - Magnetic recording media and ternary (perovskite-type) superionic conductors (Okayama U., Japan)
  - High T_c cuprate superconductors, and novel Ru-based perovskite superconductor that exhibits an unusual coexistence of magnetism and superconductivity (NTHU, Taiwan).
  - Ternary compounds of the form AB_2X_4 that can behave like insulators, semiconductors, and even metals (where A and B are the cations, B a transition metal, and X the anion), magnetic superconductors, for which promising applications exist if the optical, electrical, and magnetic properties can be coupled.
- Phase-change re-writable materials: The Hsinchu local community reported new thin film preparations based on chalcogenide Ge-Sb-(Te, Se) alloys for use as optical media in phase-change (e.g., DVD) recording. Taiwan is a leader in optical recording and storage media and techniques, which involves making amorphous marks in a crystalline film by a focused laser (where the marks are the data bits). Erasure involves recrystallization of the amorphous-phase marks, the rate of which is determined by crystal growth speed and nucleation rate. As slow speeds, the erase ratio and hence the carrier-to-noise ratio suffers. Researchers at the Industrial Technology Research Institute (ITRI) and NTHU are combating this and enhance the crystallization rate by doping their phase change media with transition metals to act as nucleation core elements. Japanese reporting by industrial leaders Sony, Hitachi, Pioneer, and Matsushita was absent. (Maurice)

Micro Systems

Workshop: 16th Micro/Nanomachining Workshop, Sendai, Japan, 27-29 July 2000. Professor Star Ruey-Shing Huang from the National Tsing Hua University (Taiwan) presented an overview of microsystem research in Taiwan and Professor Phan Hong Khoi from the Institute of Materials Science (Vietnam) reviewed the microsystem research efforts in Vietnam at a recent Tohoku University workshop. The Professors' briefings were based on presentations they made at the International Conference on Electrical Engineering July 24-28 held in Kitakyushu City, Japan.

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Professor Huang in his presentation stated that the National Science Council (NSC) formed a micro-electro-mechanical systems (MEMS) technical committee in 1995 leading in 1996 to the formation of the NSC MEMS program office. The NSC MEMS program office allocated approximately one million U.S. dollars in general MEMS research funds and ten million U.S. dollars to the Industrial Technology Research Institute in Hsinchu

for MEMS development in 1996. The NSC in 1998 organized three Central Research Laboratories for MEMS development. Support for these three laboratories is two million U.S. dollars per year. Professor Huang is the Director of the Hsinchu facility at the National Tsing Hua University. The other two NSC support MEMS facilities are located at the National Taiwan University, Taipei and the National Cheng University, Tainan. The objectives of the NSC program were defined by Professor Huang as:

- establishing a multi-project MEMS chip service,
- implementing a single-technology module service,
- fostering technology advancement and creation,
- catalyzing academic and industrial interaction, and
- promoting international cooperation.

The current status of these objectives is varied. A multi-project MEMS chip service is expected to be available in the near future. A wide variety of single-technology module services are currently available including deposition, sputtering, bonding, and analysis processes. New micro-technologies are being developed through NSC support such as ultra-low stress Si-rich nitrides, heavily Boron doped Si microstructures, deep Si etching methods, glass anodic bonding techniques, lift-off technology for Platinum, and highly flexible polyimide membranes. These technologies have led to the construction of micro-valves, comb-drive actuators, active micro-mirror arrays, thermal sensors, and flow sensors. Industrial interest in MEMS is on the rise in Taiwan although companies still view the MEMS market as too underdeveloped to enter at this time. Industrial entities are currently largely relying on government and university laboratories to provide a MEMS knowledge base. MEMS research in Taiwan was summarized as young, under-funded but striving to meet international MEMS research standards.

Professor Khoi described micro/nano-technology research in Vietnam as focused on investigating basic nano-science. The study of nano-science and nano-physics is one of four national research projects in Vietnam. Academic institutions such as Hanoi National University, Hanoi University of Technology, and Hue University are engaged in nano-science research. Academic nano-science research efforts are complimented by several National Centre for Natural Science and Technology of Vietnam institutes such as the Institute of Materials Science, the Institute of Chemistry, and the Institute of Physics. Vietnamese nano-science research incepted only two years ago has established a number of international joint projects and educational agreements with universities located in France, the Netherlands, Japan, and Germany. Professor Khoi's organization, the Institute of Materials Science (IMS), in Hanoi was founded in 1992 with an initial investment of approximately 5 million U.S. dollars. The IMS has branches in Nha Trang and Ho Chi Minh City. The Institute has 312 employees who possess a total of 175 BS degrees. There are four Professors and 18 Assistant Professors associated with the IMS. Since 1994 117 Master and 20 Ph.D. degrees have been granted. An international research component is a part of every Ph.D. degree. The IMS's three main research topics are magnetic material applications, semiconductor materials and applications, and the modeling of materials. Nano-science research at IMS is focused on investigating properties of nano-solids; particles approximately 10 Å in size. IMS is investigating the nature of such nano-scale phenomena as color alteration (e.g. nano-Au is red not gold), altered optical emission properties, electrical property variations (e.g. bad gap characteristics), increased magnetic effects, mechanical anomalies, and thermal property changes (e.g. nano-solids have a lower melting temperature vs. macro-solids). (Pokines)

Site Visit: The Bit Valley Association, Shibuya, Tokyo, Japan; 26 July 2000. The Bit Valley Association (BVA) is a not-for-profit organization that promotes the development of information technology (IT) venture companies in the Tokyo area. The BVA was formed in August of 1999 by Mr. Taiga Matsuyama (current Director), Mr. Haruo Miyagi (affiliated with ETIC-http://www.etic.gr.jp/) and Mr. Hirohiko Sasaki (Netyear Group-http://www.netyear.com/). The BVA's goals mirror those of technology zones such as Silicon Alley in New York City, U.S.A. So far, local and national organizations have not supported the concept of creating a venture IT zone in Tokyo. Currently one full-time employee, Ms. Reiko Matsuura, handles daily operations. The Association has over 6000 members or participants. The BVA promotes IT development by organizing monthly seminars aimed at introducing the IT industry to companies, universities and government agencies and developing cooperative relationships. Many BVA members are Internet content providers. In Japan mobile phones are a common Internet platform. Japanese mobile phones exhibit characteristics similar to micro/nano-devices in scale (cm), power, and fabrication methods (Si based). Future phones are predicted to include micro-devices to provide global positioning, enhanced video imaging & storage, and personal health monitoring. Unique Japanese mobile phone software innovations will potentially be transformed into micro/nano-device operating systems. The BVA's promotion of venture IT companies could impact future generations of micro/nano-systems. (Pokines)

Site Visit: The Research Institute of Electrical Communication (RIEC), Tohoku University, Sendai, Japan, 19 June 00. Dr. Ken-ichi Arai leads a team of researchers investigating wireless actuator systems based on magnetic materials that walk, fly, and swim. Dr. Kazushi Ishiyama has been a key participant in this research for the last 5 years. The researchers at RIEC have demonstrated a proof-of-concept 10 mm long actuator system operating within a 100 Gauss magnetic field that "walks" forward and backward in the cm/sec speed range and jumps. A flying system with a wingspan of 20 mm has also been demonstrated. This flying device is capable of free flight within a magnetic field of 500 Gauss. The wing flapping frequency is between 0 and 80 Hz. The hand assembled flying system uses a combination of hard and soft magnetic films to achieve wing actuation and flight stability. Magnetic microsystems that swim have also been fabricated and tested. These devices are driven by a rotating magnetic field forcing a NdFeB permanent magnetic in the actuator system to rotate. Systems that swim through liquids such as oil and water have been tested. Additionally an actuator has been constructed that is capable of boring into muscle tissue. Figure 1 contains a picture of the magnetically actuated biomedical microsystem.

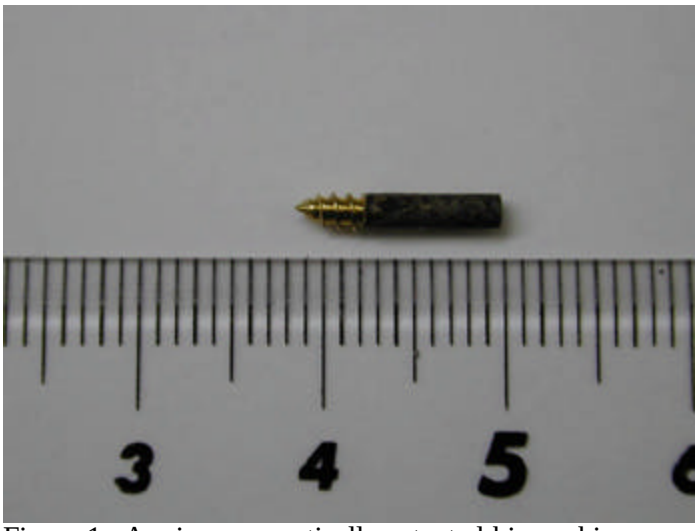

Figure 1. A micro magnetically actuated biomachine.

The swimming & boring system technology will be used for the precise delivery of biosensors and medicine to the body. Current work includes the development of a three-dimensional locating and control system. The planned completion of this work by year's end will yield a micro-bio-medical system that is capable of precisely locating &controlling a 2 mm diameter magnetic-actuator system. The team's future plans include producing a completely biologically compatible system. (Pokines)

Space

Technical Report: "Investigation of the cause of launch failure of the H-II Launch Vehicle No. 8 and future measures," Committee on Technical Assessment of the Space Activities Commission, 18 May 2000. The November 1999 failure of Japanese H-II launch vehicle (No.8) was the second straight loss in two years. The H-II vehicle was destroyed by range control officials because of an abnormal stoppage of the first stage LE-7 cryogenic engine. The failure not only resulted in the loss of the $100 million multifunctional transport satellite (MT-SAT) built by the Loral corporation, but more importantly, delayed introduction of the next generation low-cost launch vehicle, H-IIA.

The failure investigation was immediately carried out by the materials and engine experts from National Space Development Agency (NASDA), National Aerospace Laboratory (NAL), and National Research Institute for Metals (NRIM). The malfunctioned engine was located in the ocean and recovered from a depth of 3,000 meters. The investigation performed fracture analysis of each damaged part by using an electron microscope and analyzed composition of extraneous substance on the engine materials.

The results of the investigation determined that fracture was caused by metal fatigue failure on the inducer (impeller-type) of liquid hydrogen (LH_2) turbo pump. Hydrodynamic tests of the inducer and combustion tests of the LE-7 engine verified the engine anomaly characteristics. The lessons learned from this investigation will be used to redesign the inlet of the LH_2 turbo-pump for the LE-7A engine, which will be used on the H-IIA launch vehicle scheduled for first launch in 2001. (Kim)

Conference: International Symposium on Satellite Remote Sensing Towards 21st Century (RESTEC 25th Anniversary Symposium), Tokyo, Japan, 10-11 July 2000. The Remote Sensing Technology Center of Japan (RESTEC) was established in July 1975 and has been promoting satellite remote sensing in collaboration with the Science and Technology Agency of Japan (STA), the National Space Development Agency of Japan (NASDA), and other governmental agencies and universities. Remote sensing utilization has advanced remarkably with progress in related technologies, including both hardware and software of data processing/analysis and sensors. The theme of this symposium was the collaboration on

international satellite remote sensing between governmental agencies and private sectors.

On the first day, the symposium focused on activities of different countries including Japan, US and EU. In the first presentation "Earth Observation Program in Japan by Furuhama" (NASDA), the Earth Observation Satellite (EOS) program was reported, based on contributions to earth science, practical use of earth observation data and technology development. Presentations from US were "NOAA Satellite Systems and Commercial Licensing Services" by Wood (NOAA) and "NASA's Earth Science Enterprise Status and Strategic Directions" by Kirkham (NASA Tokyo office).

On the 2nd day, the technological development of EOS was specifically addressed. The reports were mainly from the various users and the private sector. Panel discussions addressed specific issues. The first session (10 July) was related with the role of government agencies for promotion of utilizing satellite remote sensing. The second (11 July) was on "new stage of collaboration between government and industries in the next century. " Three models were proposed in relation with business models; pure government model, purely commercial model and hybrid model.

The detailed abstracts are provided at the web-site of RESTEC (URL: http://www.restec.or.jp). (Miyazaki)

Workshop: 22nd Space Station Utilization Workshop in Japan, Tokyo, Japan, 28-30 June 2000. The first workshop of space station utilization was held in 1985. This year the 22nd workshop introduced the progress in Japan and other member countries of the utilization of International Space Station (ISS) which NASDA continues to construct under collaboration with NASA, ESA and others. The better planning for space environment experiments utilizing "Kibo" (Japanese Experimental Module, JEM) was expected through discussion with users of space environmental facilities.

On the first day, the utilization plan outline of the space station of each country was overviewed by delegates from NASDA, NASA, ESA and CSA. International solicitation for life science and microgravity science experiment was explained in detail, based on the usage of Japanese JEM. R&D activities for applied research were also reviewed.

On the 2nd day, technical discussions on flight and ground-based experiments within the pressurized module addressed the following topics; microgravity science, life science (biology and biotechnology) and space medical science. Two special sessions were then held for introduction of new utilization development. The "Humanity and Social Science Field" (Dr. Nakagawa, director of Kyoto National Museum) and "Fundamental Physics Field" (Prof. Sato, Kyoto Univ.) gave us novel insight into space research.

On the 3rd day, delegates from NASDA, NASA and ESA exchanged information about use of exposed payload, especially on agency's states and strategic plan of exposed payload on the ISS. Sectional meetings of environment conditions of the ISS/JEM exposed payload were held. They were related with earth science and observation, space science and observation, and space technology development.

Five visions for Japan were exhibited as the summary of the workshop: appeal to public for manned-space activity, development of space frontier by space robotics, internationally competitive space activities, shift to space development for human-security, and space culture and new intelligent industries.

Proceedings are available from Space Utilization Advancement Center (e-mail: sepd@jsup.or.jp). (Miyazaki)

Conference: The 7th Session of the Asia-pacific Regional Space Agency Forum (APRSAF-7), Tokyo University, Tokyo, Japan, 19-22 June 2000. The Asia-Pacific Regional Space Agency Forum (APRSAF) was established in 1992 to exchange views, information on space activities, and future cooperation among the region. Six forums have been held since then, mostly in Tokyo, and hosted by three Japanese government organizations: the Science and Technology Agency (STA), the Institute of Space and Astronautical Science (ISAS) and the National Space Development Agency of Japan (NASDA). The main objective of APRSAF was to review progress of cooperative plans and programs for further cooperation within the Asia-Pacific region, and the seventh session was held to issue a joint communique which would give suggestions to this forum for direction in the new century. The general chairperson was Emeritus Professor S. Murai of Tokyo University.

This session covered a wider areas than before, from earth observation, space education, and space utilization to satellite utilization in communication, broadcasting and global positioning. In other words, the themes of this session were information exchange toward future collaboration between Asia-Pacific Rim countries, and dissemination and education for space utilization technology in this region.

The contents of six sessions were:

- Space Education and Public Relations,
- Space Environment Utilization,
- Geography Information Systems by Using Earth Observation Data, Infrastructure Consolidation for Earth Observation,
- Earth Observation Data Application in the Field of the Administration, and
- Satellite Utilization Projects in the Fields of Communication, Broadcasting, and Global Positioning.

All reports of the last session were provided from Japan, including NASDA, Communication Research Lab., Toshiba, NEC and Mitsubishi. The new "IT Space Infrastructure" was proposed. The detailed joint communique is summarized on the NASDA web site - http://yyy.tksc.nasda.go.jp/Home/Press-j/200006/ aprsaf_ 000628_h02_j.html). (Miyazaki)

Workshop: Space Business for the 21st Century (3rd Symposium on Space Industry), Tokyo, Japan, 6 March 2000. The workshop was sponsored by the Institute for Unmanned Space Experiment Free Flyer (USEF) which is a non-profit organization endowed by 13 companies and is managed under the guidance of the Ministry of International Trade and Industry (MITI). In the 21st century, various fields of space technologies will be expanded into new industries. Therefore, the symposium was held to gather specialists from Japan and abroad to discuss expansion of space-related businesses in the next century. The future vision and issues of space industries obtained at the symposium will be used efficiently in making next year's roadmap for the USEF activities.

The main topical lectures were:

- MITI's Policy on Space Industry Technology by Saiki (MITI),
- The European Space Industry Today by Bayser (Alcatel),
- A Global System for the 21st Century by Dooley (INTELSAT),
- Space Finance Issues Driving Future Space Industry by Kreisel (GENES GmbH),
- Japanese Space Industry in the 21st Century from the Viewpoint of Economics by Shimizu (Keio Univ.),
- Expectations to the Activity of Japanese Space Industry in the 21st Century (a panel discussion coordinated by Torii of Nikkei Shinbun).

Space industry is now in the state of dramatic restructuring throughout the world, particularly in Europe. INTELSAT will be soon privatized. In Japan, the space industry is not expected to become one of the big business markets (core business). Basically, transition of space technology to space utilization applications should be indispensable for the success of the future Japanese advanced technology. Several promising application areas are global environment, energy resources and Information technology (IT).

Addendum: The USEF was established in 1986 to promote development of the unmanned space experiment system (a system for conducting experiments in the microgravity environment of space), R&D of equipment (including integration), and the operational control system as well as to conduct research and other activities as related to the above systems. They are currently focusing their activities into the followings; Space Flyer Unit (SFU), Experiment Re-entry Space System (EXPRESS), Unmanned Space Experiment Recovery System (USERS), Space Environment Reliability Verification Integrated System (SERVIS), and Space CALS. (USEF: http://www.usef.or.jp). (Miyazaki)

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Date	Name	Place
Sep 5-8, 00	International Symposium on Optical Memory 2000 (ISOM 2000)	Hokkaido, Japan
Sep 10-14, 00	16th Int'l Workshop on Rare-Earth Magnets and Their Applications 11th Int'l Symposium on Magnetic Anisotropy and Coercivity in Rare-Earth Transition Metal Alloys	Sendai, Japan
Sep 10-14, 00	2000 International Symposium on Formation, Physics, and Device Application of Quantum Dot Structures (QDS2000)	Hokkaido, Japan

Sep 10-15, 00	The 11th International Conference on Molecular Beam Epitaxy	Beijing, China
Sep 11-13, 00	MINPREX 2000 Int'l Congress on Mineral Processing and Extractive Metallurgy	Melbourne, Australia
Sep 11-14, 00	The 15th International Acoustic Emission Symposium 2000	Tokyo, Japan
Sep 12-15, 00	Int'l Laser and Opto-Electronic Products Exhibition	Beijing, China
Sep 13-15, 00	The International Conference on the Physics and Application of Spin-Related Phenomena in Semiconductors	Sendai, Japan
Sep 13-17, 00	Int'l Conference on Microwave & Millimeter-Wave Technology	Beijing, China
Sep 17-22, 00	25th International Conference on the Physics of Semiconductors (ICPS25)	Osaka, Japan
Sep 18-20, 00	The 6th Asian Symposium on Information Displays and Exhibition	Xi'an, China
Sep 18-21, 00	8th International Conference on Ferrite's (ICF8)	Kyoto, Japan
Sep 21-22, 00	10th Fracture Mechanics Seminar	Kyoto, Japan
Sep 24-27, 00	The 9th International Conference on Shallow-Level Centers in Semiconductors	Hyogo, Japan
Sep 24-27, 00	**International Workshop on Nitride Semiconductors**	**Nagoya, Japan**
Sep 24-28, 00	The 9th International Conference on High Pressure Semiconductor Physics	Hokkaido, Japan
Sep 24-28, 00	**Bulk Metallic Glasses (Bulk Amorphous Alloys) Conference**	**Singapore**
Sep 25-29, 00	The 14th Int'l Conference on High Magnetic Fields in Semiconductor Physics	Shimane, Japan
Sep 25-29, 00	24th International Congress on High Speed Photography and Photonics	Sendai, Japan
Sep 27-29, 00	9th International Symposium on Semiconductor Manufacturing (ISSM2000)	Tokyo, Japan
Sep 27-29, 00	IEEE International Workshop on Robot and Human Interaction (ROMAN2000)	Osaka, Japan
Oct 1-4, 00	6th International Conference on Soft Computing (IIZUKA 2000)	Fukuoka, Japan
Oct 2-6, 00	**Solar-Terrestrial Energy Program-Results, Applications and Modeling Phase**	**Sapporo, Japan**
Oct 8-10, 00	International Workshop on Chaos & Nonlinear Dynamics in Asuka	Nara, Japan
Oct 9-12, 00	SPIE 2nd Int'l Asia-Pacific Symposium on Remote Sensing of the Atmosphere, Environment, and Space	Sendai, Japan
Oct 11-13, 00	**Japan Society of Aeronautical and Space Sciences Symposium**	**Sendai, Japan**
Oct 11-14, 00	2000 International Forum on Biochip Technologies	Beijing, China
Oct 14-16, 00	International Symposium on Superconductivity 2000 (ISS 2000)	Tokyo, Japan
Oct 17-20, 00	Int'l Symposium on Surface and Interface: Properties of Different Symmetry Crossing-2000 (ISSI PDSC-2000)	Nagoya, Japan
Oct 18-19, 00	Korean EMF Workshop	Seoul, Korea
Oct 18-20, 00	The 6th Asian Symposium on Information Displays & Exhibition	Xi'an, China
Oct 18-20, 00	Advanced Metallization Conference 2000: Asian Session (ADMETA 2000)	Tokyo, Japan
Oct 19-21, 00	International Symposium on Smart Structures and Microsystems 2000	Hong Kong, China
Oct 22-25, 00	International Symposium on Micromechatronics and Human Science	Nagoya, Japan
Oct 22-28, 00	IEEE International Conference on Industrial Electronics, Control and Instrumentation (IECON-2000)	Nagoya, Japan
Oct 23-26, 00	**International Conference on Adaptive Structures & Technologies (ICAST)**	**Nagoya, Japan**
Oct 23-26, 00	2nd International Electronic Magnetic Field (EMF) Seminar	Xi'an, China
Oct 25-27, 00	The Third Asia-Pacific Conference on Simulated Evolution and Learning (SEAL2000)	Nagoya, Japan
Oct 25-27, 00	**10th International Conference on Artificial Reality and Tele-Existence (ICAT2000)**	**Taipei, Taiwan**
Oct 30-Nov 2, 00	Magneto-Optical Recording International Symposium and Asia-Pacific Data Storage Conference 2000	Nagoya, Japan
Oct 30-Nov 5, 00	International Conference on Intelligent Robots and Systems (IROS2000)	Kagawa, Japan
Nov 1-4, 00	International Topical Symposium on Advanced Optical Manufacturing and Testing Technology	Chengdu, China
Nov 5-8, 00	International Conference on Colloid and Surface Science	Tokyo, Japan
Nov 8-10, 00	Optics and Optoelectronics China 2000	Beijing, China
Nov 9-11, 00	Techno Ocean 2000	Kobe, Japan
Nov 13-14, 00	XEL 2000	Yokohama, Japan
Nov 13-17, 00	8th Conference on Frontiers of Electron Microscopy in Materials Science	Matsue, Japan

Nov 14-16, 00	1st International Conference on Systems Biology (ICSB2000)	Tokyo, Japan
Nov 14-18, 00	**7th Int'l Conference on Neural Information Processing (ICONIP 2000)**	**Taejon, Korea**
Nov 15-17, 00	2nd International Conference on Optical Design and Fabrication (ODF2000)	Tokyo, Japan
Nov 19-23, 00	**International Conference on Communication Systems (ICCS'00)**	**Singapore**
Nov 20-23, 00	3rd International Hydrology and Water Resources Symposium (Hydro2000)	Perth, Australia
Nov 26-28, 00	The Third International Conference on Computer Aided Industrial Design and Computer Aided Conceptual Design	Hong Kong, China
Nov 27-Dec 1, 00	**4th Asia Pacific Conference on Computer Human Interaction (APCHI)** **6th S.E. Asian Ergonomics Society Conference (ASEAN Ergonomics)**	**Singapore**
Nov 27-Dec 2, 00	**International Symposium on Microelectronics and Assembly (ISMA2000)**	**Singapore**
Nov 28-30, 00	IAPR Workshop on Machine Vision Applications (MVA2000)	Tokyo, Japan
Nov 29-Dec 1, 00	**2nd International Conference on Experimental Mechanics**	**Singapore**
Nov 29-Dec 1, 00	International Display Workshop	Kobe, Japan
Nov 30-Dec 2, 00	**International Symposium on GPS/GNSS**	**Seoul, Korea**
Nov 30-Dec 2, 00	International Symposium on Electronic Materials and Packaging 2000 (EMAP2000)	Hong Kong, China
Dec 3-6, 00	Sustainable Energy and Environmental Technologies	Hong Kong, China
Dec 4-7, 00	The 10th International Workshop on Inorganic and Organic Electroluminescence (EL '00)	Hamamatsu, Japan
Dec 4-8, 00	**2000 Contaminated Site Remediation Conference**	**Melbourne, Australia**
Dec 4-8, 00	The 21st Asia Conference on Remote Sensing	Taipei, Taiwan
Dec 5-7, 00	The 4th International Conference on Nano-Molecular Electronics (ICNME2000)	Kobe, Japan
Dec 5-7, 00	2nd Singapore International Symposium on Protection against Toxic Substances (SISPAT)	Singapore
Dec 6-9, 00	10th International Conference on Biomedical Engineering (10th ICBME)	Singapore
Dec 11-15, 00	Australian Optical Society Conference Australian Institute of Physics Symposium	Adelaide, Australia
Dec 13-15, 00	SPIE Smart Electronics and MEMS	Melbourne, Australia
Jan 15-17, 01	6th International Symposium on Artificial Life and Robotics (AROB)	Tokyo, Japan
Feb 5-9, 01	**Advanced Research Workshop on Semiconductor Nanostructures**	**Blenheim, New Zealand**
Feb 7-9, 01	Energy & Environment Exhibition	Tokyo, Japan
Apr 2-4, 01	International Symposium on Electromagnetics in Biology and Medicine	Tokyo, Japan
Apr 19-21, 01	32nd International Symposium on Robotics	Seoul, Korea
May, 01	**Asia Pacific Symposium on Multi-Dimenstional Microscopy 2001**	**Melbourne, Australia**
May 6-9, 01	**International Light Materials for Transportation System (LiMat 2001)**	**Pusan, Korea**
May 6-11, 01	11th Asia Pacific Military Medical Conference	Auckland, New Zealand
May 14-18, 01	**Indium Phosphide and Related Materials, 2001 (IPRM'01)**	**Nara, Japan**
May 20-24, 01	Sub Optic 2001	Kyoto, Japan
June 6-8, 01	5th International Conference on Mechatronics Technology	Singapore
June 6-8, 01	4th Asian Conference on Robotics and its Applications	Singapore
Jul 1-5, 01	Integrated Optics & Optical Communications Conference (IOOC) Opto-Electronics Communications Conference (OECC) Australian Conference on Optical Fibre Technology (ACOFT)	Darling Harbour Convention Centre, Sydney, Australia
July 1-6, 01	**5th International Symposium on Advances in Polymers and Composites**	**Singapore**
July 1-6, 01	**International Conference on Materials for Advanced Technologies (ICMAT)**	**Singapore**
July 9-13, 01	8th IFIP TC 13 Conference on Human-Computer Interaction (INTERACT 2001)	Tokyo, Japan
July 15-19, 01	The 4th Pacific Rim Conference on Lasers and Electro-Optics (CLEO/Pacific Rim 2001)	Chiba, Japan
July 15-19, 01	International Meeting of the Psychometric Society (IMPS-2001)	Osaka, Japan
July 16-18, 01	Fourth International Symposium on Impact Engineering(ISIE/4)	Kumamoto, Japan
Jul 24-27, 01	**2001 International Symposium on Signals, Systems, and Electronics**	**Tokyo, Japan**
Jul 30-Aug 4, 01	The 13th International Conference on Crystal Growth (ICCG-13)	Kyoto, Japan
Oct 2-6, 01	**The 6th International Conference on Laser Ablation (COLA '01)**	**Tsukuba, Japan**
Oct 15-19, 01	6th International Conference on Mercury as a Global Pollutant	Minamata, Japan

Oct 21-26, 01	8th International Conference on Environmental Mutagens	Shizuoka, Japan
Oct 24-26, 01	**8th Microoptics Conference (MOC'01)**	**Osaka, Japan**
Oct 29- Nov 2, 01	**Int'l Conference on Silicon Carbide and Related Materials**	**Tsukuba, Japan**
Nov 6-9, 01	**5th International Conference on Durability Analysis of Composite Systems (DURACOSYS 2001)**	**Tokyo, Japan**
Nov 11-16, 01	9th International Conference on the Conservation and Management of Lakes	Shiga, Japan
Nov 13-15, 01	**Japanese International SAMPE Symposium and Exhibition (JISSE-7)**	**Tokyo, Japan**
Jul, 02	**Topical Workshop in Heterostructure Materials (TWHM'02)**	**Japan**
Jul 7-11, 03	5th International Congress on Industrial and Applied Mathematics	Sydney, Australia

Upcoming Window-on-Science Visitors

Contact us for more details if you are interested in the following WOS visitors.

Dates	Visitor Name	Affiliation and Country	Topic	Visit Location
7-12 Sep 00	Prof. Paul Bates	Griffith University, Australia	Cooperative Research Center (CRC) and Human Factors Research	USAFSAM/CC AFRL/HE
11-15 Sep 00	Prof. Jun-ichi Sakai	Toyama University, Japan	Solar Physics	AFRL/VSBS
11-19 Sep 00	Dr. Kiyoshi Ichimoto	National Astronomical Observatory, Japan	Solar-B Optical Telescope	AFRL/VSBS HAO, Boulder, CO
25-26 Sep 00	Mr. Ken-ichi Takanashi	National Research Institute of Fire and Disaster, Japan	Communications and Information Systems for Firefighters	AFRL/MLQ
14-16 Oct 00	Prof. Chung-wen Lan	National Taiwan University, Taiwan	Bulk Crystal Growth, Computational Fluid Dynamics	AFRL/SNHX WOS/Conference, Stonybrook, NY
16-20 Oct 00	Dr. You-Seop Lee	Pohang University of Science & Engineering, Korea	Stability of Buoyancy-driven Convection in CZ-growth & Effect of Cusp Magnetic Field on Traveling Thermal Wave in CZ Crystal Growth	AFRL/SNHX
17-21 Oct 00	Dr. Dong Ho Kim	Korea Advanced Institute of Science & Technology, Korea	Numerical Simulation of Material Processes	AFRL/SNHX
17-21 Oct 00	Prof. Do Hyun Kim	Korea Advanced Institute of Science & Technology, Korea	Mathematical Modeling of Material Processes	AFRL/SNHX
26 Nov-1 Dec 00	Dr. Shigefusa Chichibu	University of Tsukuba, Japan	GaN Semiconductor Devices & Physics	WOS/Conference in Boston, MA
19-21 Dec 00	Prof. Hosung Sun	Sungkyunkwan University, Korea	Computational Materials Chemistry	WOS/Conference in Maui, HI
19-21 Dec 00	Prof. Yuriko Aoki	Hiroshima University, Japan	Computational Materials Chemistry	WOS/Conference in Maui, HI
19-21 Dec 00	Prof. Takako Kudo	Gunma University, Japan	Computational Materials Chemistry	WOS/Conference in Maui, HI
19-21 Dec 00	Dr. Kiyoyuki Terakura	National Institute for Advanced Interdisciplinary Studies, Japan	Computational Materials Chemistry	WOS/Conference in Maui, HI

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